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GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

DURUM

SECTION A

INTRODUCTION

MORE INFORMATION

GRDC 'Fact Sheet — Durum Quality and Agronomy': www.grdc.com.au/GRDC-FS-Durum

DPIRD 'Development of the Durum Industry in the Western Region': http://www.agrifood.info/review/2007/Nguyen_Llewellyn_Miyan.pdf

NSW Department of Primary Industries 'Durum Wheat Production': www.dpi.nsw.gov.au

Introduction

A.1 Overview

Durum wheat (*Triticum turgidum*) is closely related to bread wheat (*T. aestivum*), but is grown for pasta production.

The highest grade of Australian durum wheat — ADR1 — is known for its extreme hardness, high protein, intense yellow colour and milling qualities that make it suitable for producing semolina. This is the finely ground grain that is used to make pasta.

The market for durum wheat in Western Australia is small and niche. Growers considering producing this crop are advised to contact WA-based grain container packers to determine the marketability of the product before they consider entering the industry. See Chapter 10 for more information about durum wheat marketing.

WA's five-year average durum wheat production was only 5419 tonnes during the period 1994-95 to 2006-07 due to some poor seasons and the challenge of meeting durum grain protein requirements.[1]

In this period, production reached a high of about 7000 t in 2004-05 and there were several years of zero production including in recent years.[2]

Across Australia, durum wheat is typically grown on highly fertile soils that produce high-protein grain, as protein levels of higher than 13 percent are required to meet premium grades. Grain with protein levels of less than 10 percent is marketed as feed. Specifications for durum wheat are outlined in Table 1.

Poor soil fertility in many parts of WA make it challenging to consistently produce durum wheat at a protein level that qualifies for a premium price and is competitive with returns for other crop options, such as bread wheat.

Trials have shown there is potential to improve the grain protein of durum by including it in a legume rotation, using high rates of nitrogen (N) fertilisers and/or adopting a fallow in the rotation.

It is estimated WA is capable of producing at least 500,000 t of durum wheat annually on a potentially suitable area of three million hectares (most likely in eastern and northern grainbelt areas).[3]

The production of durum wheat in WA would add security of supply that is essential to maintaining Australia's domestic and export markets for semolina.

Benefits would flow back to growers through increased gross margins for durum wheat when grown in the appropriate conditions.

1 DAW703 (2004) Development of the Durum Industry in the Western Region, http://www.agrifood.info/review/2007/Nguyen_Llewellyn_Miyan.pdf

2 DAW703 (2004) Development of the Durum Industry in the Western Region, http://www.agrifood.info/review/2007/Nguyen_Llewellyn_Miyan.pdf

3 N Mohammed S. Miyan1, Alfredo Impiglia2, Wal K. Anderson3, Agronomic practices for durum wheat in an area new to the crop, http://agrobiol.sggw.waw.pl/~cbcs/articles/CBCS_6_2_2.pdf

Table 1: Preferred durum specifications for semolina.[4]

PASTA MANUFACTURERS	GRAIN TRADE AUSTRALIA WHEAT STANDARDS	REASON BEHIND THE SPECIFICATION
Preferred durum wheat specifications for the best quality semolina	**Industry specifications that will meet ADR1 standard and make a good quality semolina**	
At least 13 percent protein	At least 13 percent protein	Required for optimum pasta production. It produces semolina that has a uniform particle size and allows for the pasta to be physically strong and elastic.
Maximum 12 percent moisture	Maximum 12.5 percent moisture	An important parameter, particularly for processing industries and trading and will reflect grain storability.
Maximum 2 percent screenings (through 2.0 mm screen)	Maximum 5 percent screenings (through 2.0 mm screen)	Screenings are undersized grain (which can contain small foreign seeds) and is unsuitable to economically make semolina.
No material above screen chaff	0.6 percent above screen chaff	Material above the screen chaff is inconvenient for grain handlers and the processing industries and requires more extensive cleaning.
More than 90 percent hard vitreous kernels (HVK)	More than 80 percent hard vitreous kernels (HVK)	Low HVK, such as below 80 percent, can cause starchy flour production instead of semolina.
No stained grains, black point or black crease	No stained grains, black point or black crease	Fungal staining and black point creates dark flecks in the pasta sheets which are unattractive to consumers.
Test weight higher than 80 kilograms per hectolitre	Test weight above 76 kilograms per hectolitre	Poor test weight can lower the semolina yield obtained.
Falling number (FN) greater than 450 seconds	Falling number (FN) greater than 300 seconds	Weather damaged grains (FN<200) can severely affect pasta properties.
No contamination by foreign grains	Ideally, no contamination by foreign grains	Contamination of durum grain with bread wheat can increase the flour content of semolina, which affects dough performance.
No chemical contamination	No chemical contamination	Growers must follow all chemical label guidelines and monitor maximum residue limits. Pasta manufacturers have a nil tolerance.

Before broad extension and promotion of durum wheat can be successful in this State, the industry needs to overcome the perception held by many growers that durum varieties are unsuited to WA conditions and more susceptible to some diseases than bread wheats.[5] The long term success of the crop will also depend on reducing the yield gap between bread wheat and durum wheat and on the continued quality and price advantage for durum wheat.[6]

Limited trials of one of the leading Australian durum wheat varieties, DBA-Aurora⁽ᵈ⁾, have been conducted in WA by the Department of Primary Industries and Regional Development (DPIRD) – formerly Department of Agriculture and Food Western Australia (DAFWA) – alongside bread wheats to assess tolerance to abiotic stresses associated with sodic, magnesic and dispersive soils. More information is available from DPIRD researcher Dr Darshan Sharma at: darshan.sharma@agric.wa.gov.au. Adelaide University Agricultural Science department head Dr Jason Able is also interested in trials of newer durum wheat varieties in WA and can be contacted at: jason.able@adelaide.edu.au

4 Grain Trade Australia Wheat Standards (2016-17), Grain Trade Australia, http://www.graintrade.org.au

5 Nguyen, V.H, Llewellen, R.S, Miyan, M.S (2007) Explaining Adoption of Durum Wheat in Western Australia, Australasian Agribusiness Review (Vol.15 – 2007), http://www.agrifood.info/review/2007/Nguyen_Llewellyn_Miyan.pdf

6 N Mohammed S. Miyan1, Alfredo Impiglia2, Wal K. Anderson3, Agronomic practices for durum wheat in an area new to the crop, http://agrobiol.sggw.waw.pl/~cbcs/articles/CBCS_6_2_2.pdf

More than 25 field trials were carried out in this State from 2001 to 2004 at locations in low, medium and high rainfall zones and on a range of soil types to determine the most appropriate management for the production of durum wheat. The trials investigated factors such as variety, seeding rate, N rate and time of sowing.

Durum wheat and bread wheat control varieties were used in these trials and soil test data, crop emergence counts, dry matter production, grain yield and grain quality were collected each year.

This project found that successful production of durum wheat in WA depended on:

- Selection of appropriate soil types
- Crop rotation with legumes — the alternative being largely uneconomic applications of fertiliser N
- Elimination of root diseases by controlling grass weeds, due to susceptibility to crown rot (CR) (*Fusarium pseudograminearum*).[7]

These trials showed no significant yield response to N application following pasture or good pulse rotation.

Researchers suggested the release of a new variety, specifically selected and produced for conditions in the western region, could assist adoption of durum wheat.

Results from all trial sites confirmed early sowing did not reduce grain quality where the combination of soil type and legume rotation were appropriate.[8]

A.2 Durum wheat economics and grain quality

The 2001-2004 WA trials showed if durum wheat was grown on neutral to alkaline clay loam soils following good quality legume pastures or crops, profitability potential was equal to — or higher than — that of bread wheat in some parts of the State.[9,10]

When grown in medium to low rainfall areas on clay loam soils, the best durum wheats yielded only 5-10 percent less than the best performing bread wheats.

Durum wheats are more susceptible than bread wheats to crown rot, but all durum wheat varieties are triple rust resistant and resistant to moderately resistant (R-MR) to *Septoria nodorum* blotch (SNB).

As shown in Table 2, the highest grade of durum (ADR1) must have a minimum protein level of 13 percent and the protein requirement for the ADR2 grade is higher than 11.5 percent. Careful management of soil N is essential to achieve this.

Table 2: Major durum wheat quality classes*[11]

	Protein	Vitreous kernels	Falling number	Screenings	Stained grains*
ADR1	13.0%	>80%	>300	<5%	<3%
ADR2	11.5–12.9%	>70%	>300	<5%	<5%
ADR3	10.0–11.4%		>250	<10%	<20%
Feed	<10.0%				

* Includes black point.

7 Nguyen, V.H, Llewellen, R.S, Miyan, M.S (2007) Explaining Adoption of Durum Wheat in Western Australia, http://www.agrifood.info/review/2007/Nguyen_Llewellyn_Miyan.pdf

8 Anderson, W.K (2004) Development of the Durum Industry in the Western Region, http://finalreports.grdc.com.au/DAW703

9 Nguyen, V.H, Llewellen, R.S, Miyan, M.S (2007) Explaining Adoption of Durum Wheat in Western Australia, Australasian Agribusiness Review (Vol.15 – 2007), http://www.agrifood.info/review/2007/Nguyen_Llewellyn_Miyan.pdf

10 Anderson, W.K (2004) Development of the Durum Industry in the Western Region, http://finalreports.grdc.com.au/DAW703

11 Anderson, W.K (2004) Development of the Durum Industry in the Western Region, http://finalreports.grdc.com.au/DAW703

A.3 Agronomic factors

Paddock and soil type selection are essential to achieve high-yielding, high-protein durum wheat crops.

This crop performs well on deep, friable and well-drained red clay loam soils with a pH of 5.5 or above and does not tolerate acid soils.

A good legume rotation, with excellent grass weed control, is essential to ensure grain protein standards are met. At a minimum, the crop grown immediately before durum wheat in the rotation should be a pulse or a legume-based pasture.

Early sowing is beneficial for high grain yield and protein. It is recommended that growers sow newer durum wheat varieties, as these are better adapted to current growing conditions and are higher-yielding. It is advisable to use a 10 percent higher seeding rate for durum wheat than bread wheats when sowing early in WA.

Target plant density is 100-150 plants per square metre in low and medium rainfall areas. This typically requires a seeding rate of 65-75 kilograms/ha.[12]

It is advised to select planting seed from paddocks with good fertility history and test for germination, vigour and purity. Seeds should also be free from contamination with bread wheat and other cereals.

Soil testing prior to sowing is recommended to help develop a N budget for the crop.

Planning the time of sowing and early N applications are critical. Applications of N at sowing, or up to the start of stem elongation, contribute more to crop biomass and grain yield response compared to later applications, which facilitate greater protein responses. Too much applied N can result in durum wheat crops setting an unattainable yield potential.

The target depth for sowing is 25-35 millimetres, due to the short to medium coleoptile length of durum wheat varieties.[13]

Correct header settings and harvest management can reduce chaff, which causes problems for millers when cleaning the grain. Growers are advised to consider wind and quantity of grain and straw going through the machine to reduce chaff loads.

Similar to bread wheats, grain moisture at harvest for durum wheat should be no higher than 12.5 percent. Pasta produced from weather-damaged grain will not hold its shape when cooked.

12 Anderson, W.K (2004) Development of the Durum Industry in the Western Region, http://finalreports.grdc.com.au/DAW703

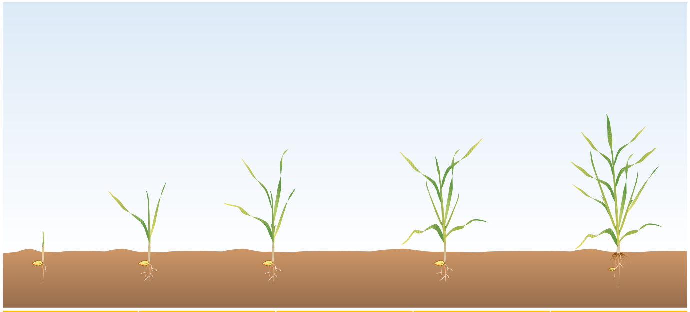
13 Anderson, W.K (2004) Development of the Durum Industry in the Western Region, http://finalreports.grdc.com.au/DAW703

A.4 Plant development and growth stages

Successful durum wheat crop management requires an ability to identify wheat growth stages and understand how these are influenced by nutrition, disease, application of herbicides and fungicides and environmental stressors.

The developmental stages of a wheat plant and the phases during which potential and actual yield are set are outlined in Figure 1.

Figure 1: *Zadoks Growth Scale for wheat*[14]
Developmental phases of a wheat plant from germination through to maturity and the Zadoks Growth Scale associated with each phase.



Zadoks Growth Scale	GS 00-09	GS10-19	GS20-29	GS30-39	GS40-49
Development phase	Germination	Seedling growth	Tillering	Stem elongation	Booting

Zadoks Growth Scale	GS 50-59	GS60-69	GS70-79	GS80-89	GS90-99
Development phase	Ear emergence	Flowering	Milk development (grain fill period)	Dough development (grain fill period)	Ripening

The Zadoks Growth Scale outlines the 10 distinct development phases of cereal crops and covers 100 individual growth stages.[15] See Chapter 3 for more information.

14 Anderson, W.K. The Wheat book: principles and practice, 2000, http://researchlibrary.agric.wa.gov.au/cgi/viewcontent.cgi?article=1005&context=bulletins

15 Anderson, W.K. The Wheat book: principles and practice, 2000, http://researchlibrary.agric.wa.gov.au/cgi/viewcontent.cgi?article=1005&context=bulletins

A.5 Estimating grain yield

There are four components to wheat grain yield:

» Number of ears (heads)/m^2

» Number of spikelets per ear

» Number of grains per spikelet

» Weight per grain.

Ear and spikelet numbers are set well before flowering, grain numbers are set around flowering and grain weight is set between flowering and maturity.

Grain weight is the least variable of the yield components because it is largely determined by the genetic potential of the variety.

Grain yield is, therefore, most closely related to the number of grains produced by the crop.

Wheat yield can respond to seasonal conditions almost to maturity, due to the capacity of the wheat plant to increase or decrease some or all of its yield components.

The yield of a wheat crop can be estimated by:

» Grain yield (kg/ha) — this is equal to: ears/m^2 x grains/spikelet x weight/grain (g) x 10

» Ears/m^2 — count the ears in 1 m^2 of crop or count the number of ears in a 1 m row length and multiply by 5.6 (there are 5.62 m of row in one square metre for a 7-inch or 17.8 cm row spacing). For 12-inch, or 30 cm, row spacing, multiply by 3.3

» Spikelets per ear — count the number of spikelets on an average ear. For most crops it will be between 16-20

» Grains per spikelet — count the grains in spikelets at the top, middle and bottom of the ear. More and heavier grains are usually set in the central spikelets. The number should be between two and four

» Grain weight — grain weight depends on growing conditions and variety, but will usually be between 0.0025 and 0.045 g/grain (2.5-4.5 mg). To determine grain weight, count and weigh 1000 grains and divide by 1000 to get weight/grain. If it is not possible to weigh grain, a good average figure to use is 0.0356 g/grain (3.56 mg/grain), which is equivalent to 28 grains/g

» Grain yield — using the components above, the grain yield can be calculated as: Yield = 100 (ears/m^2) x (18 spikelets x 2 grains/spikelet x 0.03 g/grain) = 100 x 1.08 = 108 g/m^2 or 1.08 t/ha

» This leads to the very simple rule of thumb that 100 ears/m^2 will generate about 1 t/ha of grain.